first activation of the new game switch 20, the central processing unit 30, interrupts its current processing and initializes a timer which establishes a time period within which the player must reactivates the new game switch 20 in order to initiate a new game. If the player fails to reactivate the new game switch within the established time, the logic control flow returns to the point where it was interrupted to continue the current game. Upon the second activation of the new game switch 20, within the established time, the central processing unit 30 causes the pulse generator 64 to generate a reset pulse and the logic control flow then proceeds to the reference marker B of FIG. 5 to initiate a new game.

As will be understood by those skilled in the art, many different programs may be utilized to implement the flow charts disclosed in FIG. 5 through FIG. 22. Obviously these programs will vary from one another in some degree. However, it is well within the skill of the computer programmer to provide particular programs for implementing each of the steps of the flow charts disclosed herein. It is also to be understood that the foregoing detailed description has been given for clearness of understanding only and is intended to be exemplary of the invention while not limiting the invention to the exact embodiment shown. Obviously certain modifications, variations and improvements will occur to those skilled in the art upon reading the foregoing. It is therefore to be understood that all such modifications, variations and improvements have been deleted herein for the sake of conciseness and readability but are properly within the scope and spirit of the following claims.

What is claimed and desired to be secured by letters of patent of the United States is:

1. An electronic game device comprising:

a. a box,

b. means for generating a plurality of codes hereinafter refered to as operating codes,

c. plurality of entry control means,

d. plurality of routing means defining a respective plurality of playing positions on the surface of said box, each of said routing means being actuable by said entry control means to route said operating codes within the device,

e. means to generate a plurality of codes, hereinafter refered to as color codes, from said plurality of operating codes,

f. plurality of multi-color light emitting means,

g. means to route said color codes to said light emitting means in accordance with the determination of said routing means,

h. means to decode said plurality of color codes and activate said plurality of multi-color light emitting means,

i. means for varying the level of difficulty of any particular game, and

j. sensorially perceptible indicating means responsive to said entry control means for generating a first sensorially perceptible indication corresponding to each activation of the entry control means, a plurality of sensorially perceptible and distinct indications each of which is corresponding to each of a plurality of predetermined colors being displayed at all multi-color light emitting means and a sensorially perceptible indication corresponding to the successful completion of a game.

2. An electronic game device as recited in claim 1 further comprising means to flash said multi-color light emitting means.

3. An electronic game device as recited in claim 1 wherein said entry control means and multi-color light emitting means include a plurality of multi-color lighted switches.

4. An electronic game device as recited in claim 1 wherein said means to generate a plurality of color codes

includes means to implement a plurality of logic boolean functions.

5. An electronic game device as recited in claim 1 wherein said operating codes and color codes are binary.

6. An electronic game device as recited in claim 1 wherein each of said plurality of light emitting means is associated with each of said playing positions.

7. An electronic game device as recited in claim 1 wherein said means to vary the level of difficulty of any particular game includes means for changing the apparent positions of said entry control means, the apparent positions of said multi-color light emitting means or both.

8. An electronic game device as recited in claim 1 wherein each of said plurality of color codes corresponds to either each of a plurality of predetermined colors or to a dark indication.

9. An electronic game device as recited in claim 1 further comprising means to provide a plurality of games.

10. An electronic game device as recited in claim 9 wherein said means to provide a plurality of games includes a microprocessor which generates sets of random operating codes for each new game.

11. An electronic game device as recited in claim 1 wherein each of said plurality of entry control means includes a key pad switch.

12. An electronic game device as recited in claim 1 wherein said sensorially perceptible indications are aural.

13. An electronic game device as recited in claim 12 wherein at least one of said aural outputs comprises a combination of successive tones of different frequencies.

14. An electronic game device as recited in claim 1 further comprising means to conserve electrical energy.

15. An electronic game device as recited in claim 1 wherein the shape of said box can be any three dimensional geometric configuration and wherein said plurality of playing

(Claim 15 to 23)

positions are mapped on the surface of said geometric configuration.

16. An electronic game device as recited in claim 1 further comprising mode means for controlling said electronic game device to operate in a predetermined number of different levels of difficulty, said controlling means comprising manually operable means for selecting each of said predetermined number of different operating difficulty levels, said difficulty levels mean changing the apparent positions of said entry control means and/or changing the apparent positions of said multi-color light emitting means.

17. An electronic game device as recited in claim 1 wherein a microprocessor is utilized to control the progress of the game, generate sets of operating codes, monitor the actuation of said entry control means, simulate the operation of said routing means to route said operating codes within the device, compute said color codes from said operating codes by executing a plurality of predetermined boolean functions, randomly map the actual positions of said entry control means into a respective plurality of apparent entry control means in order to vary the difficulty of the game, randomly map the actual positions of said multi-color light emitting means into a respective plurality of apparent multi-color light emitting means in order to further vary the difficulty of the game, address each of said multi-color light emitting means to automatically route each of said color codes to its respective multi-color light emitting means in accordance with the determination of said routing means, control the flashing of said multi-color light emitting means, and to generate a sequence of audio tones to produce said sensorially perceptible indications.

Sub Q4 18. An electronic game device as recited in claim 17 further comprising controlling means for terminating the current game and initiating a new game, said controlling means comprising manually operable means to cause said device to

reset its memory and generate a new set of operating codes.

19. An electronic game device as recited in claim 17 wherein said sensorially perceptible indications are synchronized with said multi-color light emitting means.

20. An electronic game device as recited in claim 17 further comprising addressing means to sequentialy activate said multi-color light emitting means, for a predetermined time duration and in accordance with a predetermined activation sequence, in response to each activation of said entry control means.

21. An electronic game device comprising:

a. a box,

b. means for generating a plurality of codes hereinafter refered to as operating codes,

c. plurality of entry control means,

d. plurality of routing means defining a respective plurality of playing positions on the surface of said box, each of said routing means being actuable by said entry control means to route said operating codes within the device,

e. means to pictorially represent a plurality of images wherein each of said plurality of playing positions is indicated to provide a plurality of display positions, each of said display positions is used to indicate any of said plurality of images,

f. means to generate a plurality of codes, hereinafter refered to as display codes, from said plurality of operating codes,

g. means to route said display codes to said display positions in accordance with the determination of said routing means,

h. means to activate each of said plurality of display positions to provide a pictorial representation of the received display code,

i. means for varying the level of difficulty of any

particular game, and

j. sensorially perceptible indicating means responsive to said entry control means for generating a first sensorially perceptible indication corresponding to each activation of entry control means, a plurality of sensorially perceptible indications each of which is different from said first sensorially perceptible indication and corresponding to each of said plurality of images being displayed at all display positions, and a sensorially perceptible indication corresponding to the successful completion of a game.

24 ~~22~~. An electronic game device as recited in claim 23 ~~21~~ further comprising means to flash said display positions.

25 ~~23~~. An electronic game device as recited in claim 23 ~~21~~ wherein said means to generate a plurality of display codes includes means to implement a plurality of logic boolean functions.

~~24~~ 26. An electronic game device as recited in claim 23 ~~21~~ wherein said operating codes and display codes are binary.

~~25~~ 27. An electronic game device as recited in claim 23 ~~21~~ wherein said means to vary the level of difficulty of any particular game includes means for changing the apparent positions of said entry control means, the apparent positions of said display positions or both.

~~26~~ 28. An electronic game device as recited in claim 23 ~~21~~ wherein each of said plurality of display codes corresponds to either each of said plurality of predetermined images or to a blank display.

~~27~~ 29. An electronic game device as recited in claim 23 ~~21~~ further comprising means to provide a plurality of games.

~~28~~ 30. An electronic game device as recited in claim 29 ~~27~~ wherein said means to provide a plurality of games includes a microprocessor which generates sets of random operating codes for each new game.

~~29~~ 31. An electronic game device as recited in claim 23 ~~21~~

wherein each of said plurality of entry control means includes a key pad switch.

~~32~~ 30. An electronic game device as recited in claim ~~21~~ 23 wherein said sensorially perceptible indications are aural.

~~33~~ 31. An electronic game device as recited in claim ~~30~~ 32 wherein at least one of said aural outputs comprises a combination of successive tones of different frequencies.

~~34~~ 32. An electronic game device as recited in claim ~~21~~ 23 further comprising mode means for controlling said electronic game device to operate in a predetermined number of different levels of difficulty, said controlling means comprising manually operable means for selecting each of said predetermined number of different operating difficulty levels.

Sub a8 33. An electronic game device as recited in claim 21 wherein a microprocessor is utilized to control the progress of the game, generate sets of operating codes, monitor the actuation of said entry control means, simulate the operation of said routing means to route said operating codes within the device, compute said display codes from said operating codes by executing a plurality of predetermined boolean functions, randomly map the actual positions of said entry control means into a respective plurality of apparent entry control means in order to vary the difficulty of the game, randomly map the actual positions of said display positions into a respective plurality of apparent display positions in order to further vary the difficulty of the game, generate a plurality of graphic symbols, each of said graphic symbols corresponds to each of said plurality of images, address each of said plurality of display positions to automatically route each of said display codes to its respective display positions, in accordance with the determination of said routing means, to provide the pictorial display codes, control the flashing of said display positions, and to generate a sequence of audio tones to produce said sensorially perceptible indications.

Sub a9 34. An electronic game device as recited in claim 33

(Claims 35-45)

36.

further comprising controlling means for terminating the current game and initiating a new game, said controlling means comprising manually operable means to cause said device to reset its memory and generate a new set of operating codes.

Sub A10 35. An electronic game device as recited in claim 33 further comprising means for producing video signals, wherein each of said plurality of entry control means includes a key pad switch and wherein said plurality of display positions are provided on a vedio monitor.

Sub A11 36. An electronic game device as recited in claim 33 wherein said plurality of images include a geometric shape depicted in various colors.

Sub A12 37. An electronic game device as recited in claim 33 wherein said means for pictorially representing said plurality of images comprises an LCD display.

Sub A13 38. An electronic game device as recited in claim 33 wherein said means for pictorially representing said plurality of images comprises an LED display.

Sub A14 39. An electronic game device as recited in claim 33 wherein said sensorially perceptible indications are synchronized with said pictorially display means.

Sub A15 40. An electronic game device comprising:

a. a box,

b. means for generating 2N codes hereinafter refered to as operating codes,

c. N^2 entry control means,

d. N^2 routing means defining a respective N^2 playing positions on the surface of said box, each of said routing means being actuable by said entry control means to route said operating codes within the device,

e. means to generate 2N codes, hereinafter refered to as color codes, from said operating codes, each of N of said color codes corresponds to each of N predetermined colors, the remaining N color codes correspond to a dark display,

f. N^2 multi-color light emitting means, each of said light emitting means is associated with each of said N^2 playing positions,

g. means to route said color codes to said light emitting means in accordance with the determination of said routing means,

h. means to decode said color codes and activate said multi-color light emitting means,

i. means for varying the level of difficulty of any particular game, and

j. sensorially perceptible indicating means responsive to said entry control means for generating a first sensorially perceptible indication corresponding to each activation of the entry control means, N sensorially perceptible and distinct indications each of which corresponds to each of said N predetermined colors being displayed at all N^2 multi-color light emitting means and a sensorially perceptible indication corresponding to the successful completion of a game.

40/41. A method of defining and solving a logic problem in an electronic logic game comprising the steps of:

a. matching a plurality of predetermined objects placed at the left and bottom edges of a square with identical objects placed at its top and right edges,

b. using a plurality of playing pieces defined as routing squares and activated by binary switches to determine the internal routes within the square which interconnect all pairs of objects that belong to a predetermined subset of all possible pairs of said plurality of predetermined objects,

c. designating a color or an image to each of said predetermined subsets,

d. causing the color or image associated with each subset to be pictorially indicated at display

locations associated with said plurality of playing pieces, as determined by said routing squares and in accordance with the positions of said binary switches,

e. observing said displays for various combinations of binary switches whereby a combination associated with one subset may be discovered resulting in the same color or image being pictorially indicated at all display positions, and

f. repeating the aforestated steps until all the combinations associated with all predetermined colors or images have been discovered.

42. A routing method in a two-dimensional plane comprising of a plurality of quad routing elements depicted as a plurality of respective geometric squares which are arranged to form a two-dimensional geometric layout, each of said routing elements is controlled by a binary switch and comprises two nodes connected to each edge of of the associated routing square (one transmitting node and one receiving node) for a total of eight (8) nodes and eight (8) possible routes within the routing square which are defined as follows:

a. if said binary switch is set to "1", then:

(i) the transmitting node at the bottom edge of the square connects to the receiving node at the top edge of the square,

(ii) the transmitting node at the left edge of the square connects to the receiving node at the right edge of the square,

(iii) the transmitting node at the right edge of the square connects to the receiving node at the bottom edge of the square,

(iv) the transmitting node at the top edge of the square connects to the receiving node at the left edge of the square, or

b. if said binary switch is set to "0", then:

(i) the transmitting node at the bottom edge of the

square connects to the receiving node at the right edge of the square,

(ii) the transmitting node at the left edge of the square connects to the receiving node at the top edge of the square,

(iii) the transmitting node at the right edge of the square connects to the receiving node at the left edge of the square,

(iv) the transmitting node at the top edge of the square connects to the receiving node at the bottom edge of the square.

Sub a17 43. An electronic game device as recited in claim 1 wherein each of said plurality of routing means includes means to implement the routing element recited in claim 42.

Sub a18 44. An electronic game device as recited in claim 17 wherein said routing means includes means to implement the routing element recited in claim 42.

Sub a19 45. An electronic game device as recited in claim 21 wherein each of said plurality of routing means includes means to implement the routing element recited in claim 42.

Sub a20 46. An electronic game device as recited in claim 33 wherein said routing means includes means to implement the routing element recited in claim 42.

Sub a21 47. An electronic game device as recited in claim 40 wherein each of said N^2 routing means includes means to implement the routing element recited in claim 42.

Add a3

Add a8 Add a16

Add a22

Dr. D3

~~APPENDIX "A"~~

A RAINBOWX LOGIC PROBLEM

Let the logic game herein be represented by a geometric square, and let the surface of the square be subdivided into N^2 multi-color sub-squares, where N denotes the number of colors which may be displayed on any sub-square.

Definition Of Operating And Color Codes:

Let D denotes a binary operating code of length n, where $n = \ln N + 1$.

Then D is a set of all possible values of a binary code of length n.

d_i; $i = 1,\ldots,2N$, is the ith code of D.

Let $m_{i,j}$; $i,j = 1,\ldots,2N$, denotes the pair (d_i , d_j).

M be a set of all possible pairs, $m_{i,j}$, of the operating binary code D.

C denotes a binary color code of length n.

Then C is a set of all possible values of a binary code of length n.

c_k; $k = 1,\ldots,2N$, is the kth code of C.

Let M_k be a subset of M, of all pairs (d_i , d_j) which satisfy: $B(d_i , d_j) = c_k$, where B is an appropriate boolean function.

Then the color assignment on the surface of the square is defined as follows:

(i) The nth digit of c_k is used to turn a display "ON" and "OFF".

(ii) The first (n-1) digits of c_k are used to select one out of N colors that may be displayed on the square.

Dr. D4

The color assignments for the "EXCLUSIVE OR" boolean function, and for N = 4 & N = 8 are shown in tables I and II respectively.

Definition Of Routing Square:

The Routing Square, $S_{i,j}$, shown in FIG. 2, is defined as a quad routing device which is activated by a two-position (binary) switch, $W_{i,j}$. A total of N^2 Routing Squares are provided in the logic game herein, and are arranged in a two-dimensional geometric layout. The Routing Square, $S_{i,j}$, is then described as follows:

Let $S_{i,j}$ denotes routing square (i, j).
$W_{i,j}$ denotes binary switch (i, j).
$t_{i,j}$ denotes the TOP edge of $S_{i,j}$.
$l_{i,j}$ denotes the LEFT edge of $S_{i,j}$.
$r_{i,j}$ denotes the RIGHT edge of $S_{i,j}$.
$b_{i,j}$ denotes the BOTTOM edge of $S_{i,j}$.

Two nodes are connected to each edge of the square, a transmitting node (X), and a receiving node (V). The Routing Square functions as follows:

If $W_{i,j}$ = "1", then:

$b_{i,j}(X)$ CONNECTS TO $t_{i,j}(V)$.
$l_{i,j}(X)$ CONNECTS TO $r_{i,j}(V)$.
$r_{i,j}(X)$ CONNECTS TO $b_{i,j}(V)$.
$t_{i,j}(X)$ CONNECTS TO $l_{i,j}(V)$.

If $W_{i,j}$ = "0", then:

$b_{i,j}(X)$ CONNECTS TO $r_{i,j}(V)$.
$l_{i,j}(X)$ CONNECTS TO $t_{i,j}(V)$.
$r_{i,j}(X)$ CONNECTS TO $l_{i,j}(V)$.
$t_{i,j}(X)$ CONNECTS TO $b_{i,j}(V)$.

Definition Of A Rainbowx Logic Game:

Having defined the operating & color codes, and the Routing Square, the logic game herein is described as follows:

As stated, the logic game is represented by a geometric square subdivided into N^2 multi-color sub-squares.

Let T denotes the TOP edge of the Square.
R denotes the RIGHT edge of the Square.

L denotes the LEFT edge of the Square.

B denotes the BOTTOM edge of the Square.

Then for a dimension "N", each edge is divided into "N" sectors as follows:

Let $t_{1,j}$; j = 1,..., N, denote TOP sectors.

$r_{i,N}$; i = 1,..., N, denote RIGHT sectors.

$l_{i,1}$; i = 1,..., N, denote LEFT sectors.

$b_{N,j}$; j = 1,..., N, denote BOTTOM sectors.

X_i; i = 1,..., 2N, denote Operating Code transmitters.

CG_j; j = 1,..., 2N, denote Color Code generators.

$CD_{i,j}$; i,j = 1,..., N, denote Color Code decoders.

The Operating Code transmitters, X_i, are connected to the left and bottom edges of the Square, and the Color Code generators, CG_j, are connected to the top and right edges of the Square, as follows:

X_i; i = 1,..., N, are connected to $l_{i,1}(X)$; i = 1,..., N.

X_i; i = N+1,..., 2N, are connected to $b_{N,j}(X)$; j = 1,..., N.

CG_j; j = 1,..., N, are connected to $t_{1,j}(V)$; j = 1,..., N.

CG_j; j = N+1,..., 2N, are connected to $r_{i,N}(V)$; i = 1,..., N.

The Color Code decoders, $CD_{i,j}$, are connected to $S_{i,j}$ as follows:

For i,j = 1,..., N:

If $W_{i,j}$ = "1" then $CD_{i,j}$ is connected to $t_{i,j}(X)$.

If $W_{i,j}$ = "0" then $CD_{i,j}$ is connected to $r_{i,j}(X)$.

Having described the logic game herein, the logic problem is defined as follows:

1. For <u>EACH</u> game, assign the Operating Codes, d_i & d_j; i,j = 1,..., 2N, to X_i; i = 1,..., 2N, and CG_j; j = 1,..., 2N, as follows:

d_i; i = 1,..., N, are RANDOMLY assigned to X_i; i = i,..., N.

d_j; j = 1,..., N, are RANDOMLY assigned to CG_j; j = 1,..., N.

Similarly,

d_i; i = N+1,..., 2N, are RANDOMLY assigned to X_i; i=N+1,..., 2N.

d_j; j = N+1,..., 2N, are RANDOMLY assigned to CG_j; j=N+1,..., 2N.

2. The Operating Codes, d_i (i = 1,..., 2N), are then

transmitted from X_i to CG_j (i,j = 1,..., 2N), via the Routing Squares. The actual route for each code, d_i, is dependent on the positions of the binary switches, $W_{i,j}$ (i,j = 1,..., N).

3. When the Operating Codes, d_i (i = 1,..., 2N), are received by the Color Code generators, CG_j (j = 1,..., 2N), they are matched with Operating Codes, d_j (j = 1,..., 2N), which were assigned to CG_j; (j = 1,..., 2N), and the operating Code pairs, $m_{i,j}$ (i,j = 1,..., 2N), are then determined.

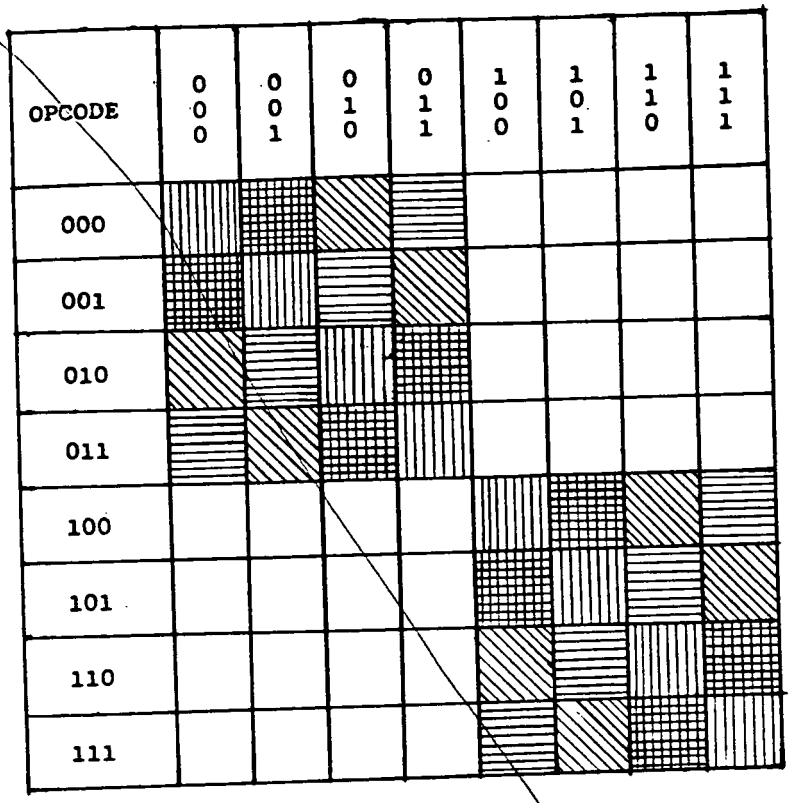
4. The Color Codes, C_j (j = 1,..., 2N), are then generated, by the Boolean Function "B", from $m_{i,j}$ (i,j = 1,..., 2N).

5. The Color Codes, C_j (j = 1,..., 2N), are transmitted from CG_j (j = 1,..., 2N) and received by Color Code decoders, $CD_{i,j}$ (i,j = 1,..., N), via the Routing Squares, where they are decoded and displayed on the multi-color sub-squares. The actual color displayed at each sub-square is dependent on the position of the binary switches, $W_{i,j}$ (i,j = 1,..., N).

6. The object of the logic game is for the player to continue to manipulate the binary switches, until all the Operating Code pairs generated belong to the same subset M_k. At such time, all the multi-color sub-squares will display the color corresponding to the Color Code, C_k.

7. By changing the positions of the binary switches, the player can continue to play the game until a different color is displayed on all sub-squares. A total of N colors can be displayed in each game.

8. For a new game, change the assignments of d_i and d_j (i,j = 1,...,2N) to X_i and CG_j (i,j = 1,...,2N).

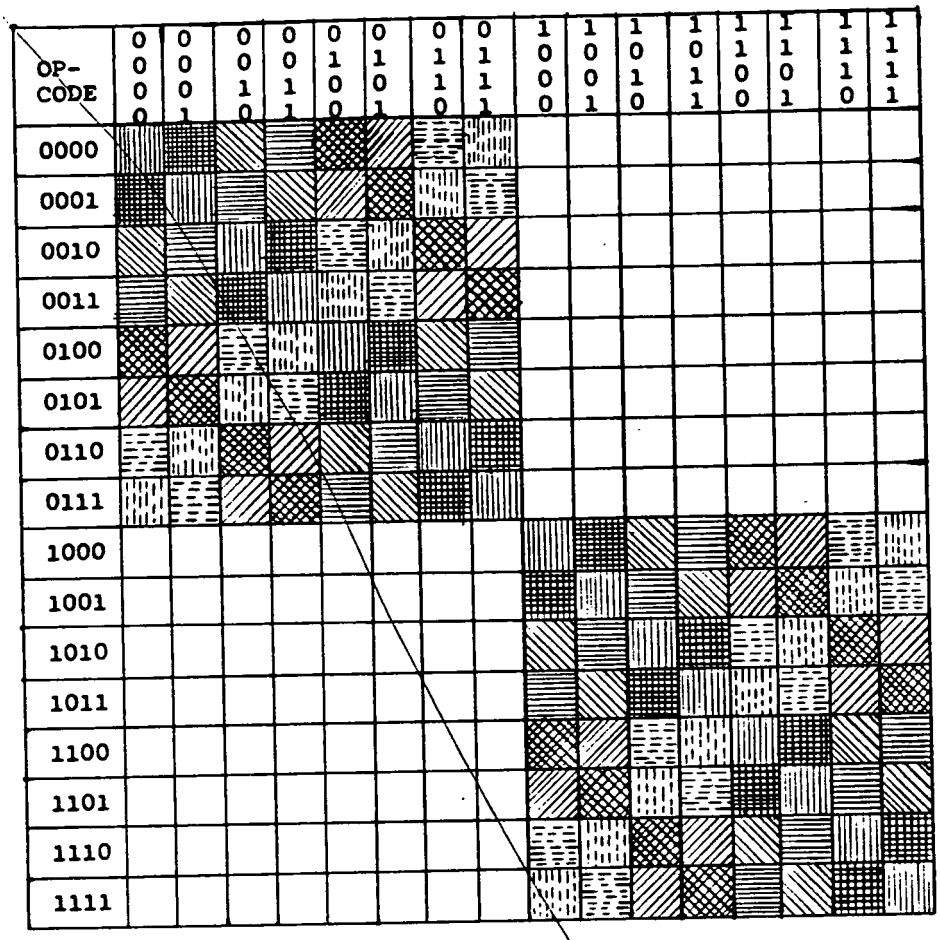


COLOR CODE	100	101	110	111
COLOR				

COLOR ASSIGNMENTS FOR N = 4

TABLE I

11/4/93
now Fig 23



COLOR CODE	1000	1001	1010	1011	1100	1101	1110	1111
COLOR								

COLOR ASSIGNMENTS FOR N = 8

TABLE II

11/4/93 JM now Fig 04